IMPROVING LEARNING IN MATHEMATICS AT KEY STAGE 2

Jenni Back and Tony Beauchamp

King's College London and NCETM, Independent research consultant

The paper describes a pilot adaptation, for teachers at Key Stages 1 & 2, of the professional development model outlined in 'Improving Learning in Mathematics' (Swan 2005). Initially, suitable tasks for children were trialled with a Year 5 class of low attaining children over the course of an academic year. The children's attitudes to maths, and their SATs scores, were monitored over the same period. Work on the professional development course followed and the course has been trialled with a group of 14 primary school teachers. The paper presents some initial analysis of data gathered from the pilot study as well as preliminary observations of teachers' practice prior to the commencement of the CPD course.

INTRODUCTION

This account describes a pilot study which is developing and trialling a CPD course for primary mathematics teachers based on Malcolm Swan's Improving Learning in Mathematics (Swan 2005) work at Key Stage 4 and beyond. It arose out of Jenni's interest both in the creation of rich mathematical tasks and the quality of communication about mathematics in primary mathematics classrooms. The Improving Learning in Mathematics approach, with its emphasis on communication and meaningful tasks, resonated with findings from Jenni's PhD study (Back 2004). It offered a potential way of helping primary mathematics teachers develop the quality of the mathematical communication in their classrooms and hence impact on children's learning. The principles underlying the Improving Learning in Mathematics project sought to develop active approaches to learning by working with teachers to change the learning opportunities that they offered to students. The CPD course is designed to support teachers in doing this through a course of six sessions, focusing in turn on: ways of establishing prior learning; helping learners to learn through analysing common mistakes and misconceptions; developing strategies that engage learners in active learning; developing discussion; developing questioning; and using formative assessment to support learning.

PHASE ONE

With the support and encouragement of Malcolm, Jenni spent some time during the last academic year (2005/6) working with children to develop activities that would be comparable to those devised by the Improving Learning team and based on the same principles. This pilot study work was carried out with a low attaining set from a year 5 class in a junior school in a market town within commuting distance of London. The 27 learners were mixed in terms of gender, ethnicity and social background and there were several children with English as an additional language.

In addition to developing new resources, Jenni also used a number of published resources such as those produced by BEAM, for example: the Maths Out Loud series (Ebbutt and Mosley 2006) (Mosley 2006), Big Books of Word Problems (Askew 2005) and Talk It Solve It (Pennant and Thompson 2005) books. These resources for active learning included tasks that involved: classifying mathematical objects; interpreting multiple mathematical representations; evaluating mathematical statements; using SATs questions to facilitate learning; and doing and undoing processes.

THE RESULTS OF THE PILOT STUDY

At the beginning of the academic year baseline SATs scores were collected from the children involved and an attitude questionnaire was given to them. In May this was repeated. The average expectation of an increase in scores of half a level over this period was achieved by this group. Since they were identified by their school as lower attaining students this could be considered to be a better than expected gain in test scores. We intend to follow up this analysis with comparisons of other SATs score results to elaborate on the significance of the findings. More interestingly the results from the two attitude questionnaires showed an increase in positive attitudes to maths and also in their feeling more empowered to do maths. In particular there was a marked increase in the number of children who said they liked doing mathematical puzzles and problems and a corresponding decrease in those who disliked them (Figure 1). In addition Jenni did some interviews involving two groups of three children and their comments support these findings. They expressed enjoyment of open ended problem solving tasks and talked about how much more they enjoyed maths than they had done the year before.

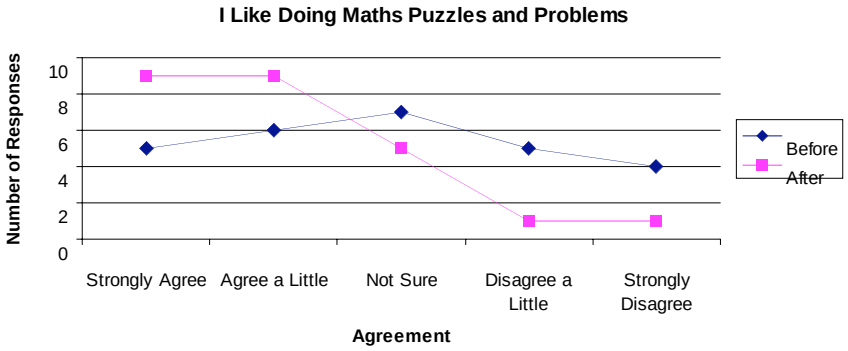

Figure 1

In Figure 2 (below) the graph shows evidence of a shift towards positive attitudes to maths and away from negative attitudes to maths. These data are taken from responses to 5 different statements relating to attitude to maths.

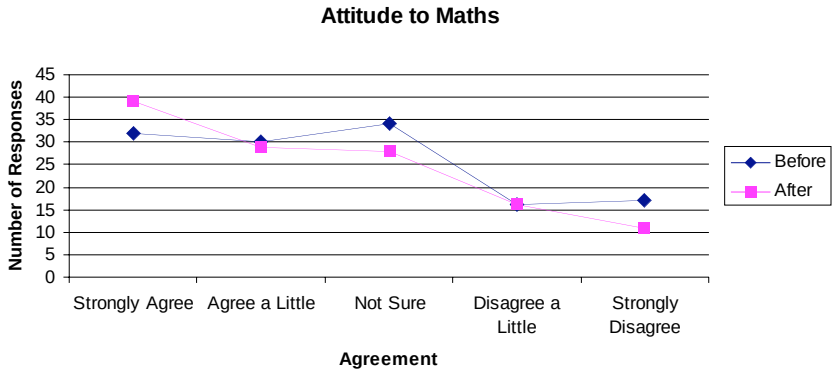

Figure 2

In Figure 3 the results show a shift away from negative feelings about engaging with mathematics and towards positive feelings about engaging with mathematics and were taken from the responses to five items on the attitude questionnaire.

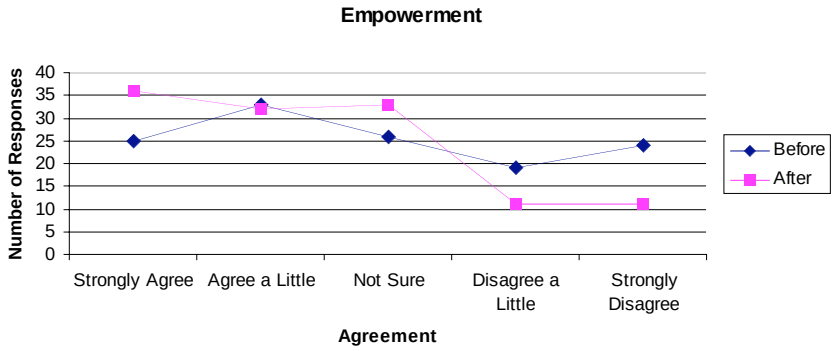

Figure 3

PHASE TWO

During the course of the academic year 2005 – 6, Jenni applied for and gained NCETM funding to conduct a small research and development project based on a development of the Improving Learning CPD course for Key Stage 2 teachers as well as the resources that had been trialled in the first phase. In addition Jenni was able to negotiate support from a north London Local Authority which was willing to offer supply cover for up to twenty-four teachers from schools in the local mathematics network. The idea was that the teachers would be involved in six half-day professional development sessions on the understanding that they trialled activities and suggestions between meetings and kept a reflective diary about their thoughts in relation both to the course and to the activities they tried with their children. A group of six of these teachers would also be observed teaching prior to the course and then interviewed and observed teaching again after the end of the course.

In September ’07 the course started and sessions were held fortnightly in each of the participating schools in turn with fourteen teachers taking part from five different schools. Each school has had a minimum of 2 teachers involved and the collegial dimension was intended to help the teachers in implementing new ideas in their classrooms. Teachers were selected to participate from each of the schools for a number of different reasons. In one case the school elected to send their entire Year 4 team of three teachers and a student, in another the head selected two teachers, the music co-ordinator and another teacher, whom she felt needed some extra support in mathematics and in a third two members of the senior management team came with a newly qualified teacher. In some cases there seemed to be no rationale behind their participation that was apparent to the teachers involved.

In the first session of the CPD course one of the activities in which the teachers participated involved sorting statements about the nature of mathematics and its teaching and learning. Audio recordings and photos of this activity have yet to be analysed. In addition six of the teachers were observed teaching in the first three weeks of the autumn term and the preliminary recordings of these lessons have been analysed.

PRELIMINARY FINDINGS

Our initial analysis of the transcripts of audio recordings of the lessons and field notes shows a remarkable homogeneity between the lessons and a number of issues have been identified related to three distinct areas. These issues are related to equity, classroom culture and opportunities to engage with mathematics. In every lesson the teacher was following the guidance of the Revised Framework and teaching a topic related to the unit that was scheduled for that week and all the lessons were organised along NNS guidelines with a mental and oral starter, a main activity and some sort of concluding plenary session.

However all the lessons raised concerns about equity especially for the low attaining pupils. In every case the pupils were grouped according to attainment and the low attaining group were given the support of the learning support assistant if one was available to the class. Groups were usually named using polygons as the indicator of status with, in one case, the lowest attainment group labelled as the circle group: the higher groups having increasingly more straight sides. In one class this group was identified one at a time by name and lined up at the door to be taken out by the teaching assistant for the group activity. Although the whole class introduction to a topic included the low attaining children in the explanations and exemplification of difficult concepts, once they were engaged in their independent or group work, they were given a simplified task or one with smaller numbers. There was some recognition of the presence of low attaining pupils, but it seemed as though there was insufficient opportunity to give them differentiated explanations or tasks within the major part of the lesson. For example the following question was posed by one teacher:

> Three hundred and seventy-four. Question: what is, and some of you may not be able to get this one, what is one hundred more than that number?

The teacher is saying that some children may not be able to tackle the problem. In this case it is questionable how the task is supporting the learning of these children. At the same time there were children who could do this easily. In this case it is questionable how the task is enhancing the learning of these children. By aiming at the middle attaining section of the class both the extremes are being done a disservice. The repetition of routine procedures can be valuable in developing fluency but can become dull and tedious and fail to involve children in mathematical thinking (Back, 2004).

In one class a game was used to good effect and had the whole class jumping up or staying down on odd or even numbers. In two other classes games were used to reinforce learning of tables. These two were competitive and those with lower attainment were 'knocked out' immediately on failing to give a correct answer and took no further part in the game. The higher attainers were rewarded for their knowledge by being allowed to continue with the game and so incidentally accentuated their superiority by having more opportunity to practise.

In general the differentiation of tasks and the labelling appeared destined to widen the gap between the highest and lowest attainment groups. For the pupils who had completely mastered the techniques to be learned there was no further challenge offered other than doing more examples of the procedure involved. In one class, for instance, the children were told that:

> next time we will be going on to solving problems […..] which does include partitioning and using our place value knowledge and skills.

On enquiry by the researcher about what this would entail, the teacher replied that:

> the problems would be more examples of numbers to be partitioned, probably numbers chosen by the children.

Another observation that we made was of the homogeneity of classroom cultures across these six classrooms. On average, the main part of the lesson took up 86% of the time available. This was divided between 59% exposition by the teacher and 27% pupils working independently, in groups, or in pairs. In every class the teacher therefore dominated the talk for, on average, 59% of the lesson and in the five lessons for which complete transcripts were obtained the teacher spoke an average of 94% of the words during that time. Of even more concern was the shortness of the contributions that the children were able to make and which often consisted of one word answers that were accepted or rejected by the teacher using the ubiquitous IRF (Initiation, Response, Feedback) (Brissenden 1988) (Back 2004) sequence. Out of the 132 pupils in the five classes all but 7 made some verbal contribution although for 21% of these it was a single word, usually a number. The average contribution per pupil was overall 8 words per lesson with pupils in one class achieving only 3 words per pupil.

Much of the talk of the lessons focused on specific arithmetic procedures and attempts to develop mastery of them. The pupils' independent work was in all classes an opportunity to practise procedures taught in the remainder of the lesson. The only challenge was to repeat correctly the addition, subtraction, counting or partitioning in the manner shown earlier.

Of most concern was the lack of opportunity to think about mathematics, or engage with mathematical ideas. This was exacerbated by the teachers' dominance of the talk; the lack of autonomy on the part of the children; and the focus on routines or procedures rather than on challenging problems or tasks.

From this small sample of lesson observations prior to the intervention of the CPD course we have gathered a picture of homogeneous practice across schools and classroom which delivers the letter of the curriculum: plenty of interactive teaching, differentiated tasks, well structured lessons with clear learning objectives. However the observations raise serious questions about equity, mathematical challenge and the autonomy of pupils as learners.

REFERENCES

Askew, M. (2005). BEAM's Big Book of Word Problems (set of 3 books) word problems for Years 1 to 6. London, BEAM.

Back, J. (2004). Mathematical Talk in Primary Classrooms:

Forms of life and language games. School of Social Science and Public Policy. London, King's College London: 399.

Brissenden, T. (1988). Talking about mathematics. Oxford, Basil Blackwell.

Ebbutt, S. and F. Mosley (2006). Maths Out Loud (Year 4) speaking and listening activities for primary maths. London, BEAM.

Mosley, F. (2006). Maths Out Loud (Year 5) speaking and listening activities for primary maths. London, BEAM.

Pennant, J. and J. Thompson (2005). Talk It, Solve It: reasoning skills in maths: Years 5 & 6. London, BEAM.

Swan, M. (2005). Improving Learning in Mathematics: Challenges and Strategies. Department f. E. a. Skills, Department for Education and Skills Standards Unit.